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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
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| 10/074,353 | 02/11/2002 | Zhonghui Alex Wang | AMAT/5867/CALB/COPPER/PJS | 6841 |
| 32588 | 7590 | 11/02/2005 | EXAMINER | |
| APPLIED MATERIALS, INC. 2881 SCOTT BLVD. M/S 2061 SANTA CLARA, CA 95050 | | | LE, THAO P | |
| | | | ART UNIT | PAPER NUMBER |
| | | | 2818 | |

DATE MAILED: 11/02/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/074,353

Applicant(s)

WANG ET AL.

Examiner

Thao P. Le

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
 - If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
 - If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
 - Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 11 February 2002.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-62 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-62 is/are rejected.
- 7) ☒ Claim(s) 8 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date 1 page.
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

Information Disclosure Statement

Information Disclosure Statement (IDS) filed on 02/11/02 and made of record.

The references cited on the PTOL 1449 form have been considered.

Claim Objection

Claim 8 depends on claim 1 and cited a limitation that is not disclosed in claim 1 "step d".

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless --

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1-3, 5, 9, 10, 14, 20-22, 24, 28, 29, 33, 34, 40-42, 44, 48, 49, 53 are rejected under 35 USC 102 (e) as being anticipated by Gross et al., U.S. Patent No. 6,297,154, hereafter "Gross".

Regarding claims 1, 2, 20, 21, 40, 41, Gross discloses a method of annealing a metal layer on a substrate comprising, See Fig. 1 and Col. 2-4, forming a dielectric layer (SiO) on a substrate, forming at least one feature in the dielectric layer (interconnect), depositing a metal layer in the feature (copper deposited in the interconnect), removing atmospheric gases from the chamber (chamber is a non-oxidizing environment, lines 50-54, Col. 3), providing process gas to the chamber (argon and nitrogen, lines 30-35, Col. 5), and annealing the metal layer at a temperature of greater than 80 oC (100-400 oC, lines 50-51, Col. 3). Note that Gross discloses the chamber is a non-oxidizing environment, which means the chamber is purged with process gas such as argon and nitrogen, thus, the chamber is free of atmospheric gases when the inert gases (argon or nitrogen) are purged into the chamber.

Regarding claims 3, 22, 42, Gross discloses the removing gases comprises pumping the chamber to a pressure less than about 5 Torr (pressure was 2.9 mTorr, lines 30-35, Col. 5).

Regarding claims 5, 24, 44, Gross discloses the process gas comprises argon and nitrogen (lines 30-35, Col. 5).

Regarding claims 9, 28, 48, Gross discloses the process gas is provided to the chamber during annealing.

Regarding claims 10, 29, 49, Gross discloses the metal is copper (line 40, Col. 5).

Regarding claims 14, 33, 53, Gross discloses the metal is deposited by electroplating (line 40, col. 5).

Regarding claim 34, Gross discloses the step of planarizing the metal layer (by CMP, abstract)

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 4, 6-8, 11-13, 13, 15-19, 23, 25-27, 32, 35-39, 43, 45-47, 50-51, 54-58, 59-62 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gross et al., U.S. Patent No. 6,297,154, hereafter "Gross".

Regarding claims 4, 6-8, 11-12, 15, 17-19, 23, 25-27, 35, 37-39, 43, 45-47, 50-51, 54, 56-58, 59-61, Gross discloses the method of annealing a metal layer on a

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substrate comprising, See Fig. 1 and Col. 2-4, forming a dielectric layer (SiO) on a substrate, forming at least one feature in the dielectric layer (interconnect), depositing a metal layer in the feature (copper deposited in the interconnect), removing atmospheric gases from the chamber (chamber is a non-oxidizing environment, lines 50-54, Col. 3), providing process gas to the chamber (argon and nitrogen, lines 30-35, Col. 5), and annealing the metal layer at a temperature of greater than 80 oC (100-400 oC, lines 50-51, Col. 3). Note that Gross discloses the chamber is a non-oxidizing environment, which means the chamber is purged with process gas such as argon and nitrogen, thus, the chamber is free of atmospheric gases when the inert gases (argon or nitrogen) are purged into the chamber. Gross fails to disclose the annealing process comprises annealing the copper layer at a temperature greater than 80 oC for a duration of about 15 to 180 seconds, and reducing the temperature of the copper layer to a temperature in the range of about 50 oC to about 100 oC with a period of about 30 second, the Gross also fails to disclose the concentration and flow rate of the process gases, the duration when pumping the process gases. It is inherent that after annealing step, the layer is cool down to handling temperature, below about 50 oC. Note that the selection of such parameters such as energy, concentration, temperature, time, molar fraction, depth, thickness, etc., would have been obvious and involve routine optimization which has been held to be within the level of ordinary skill in the art. "Normally, it is to be expected that a change in energy, concentration, temperature, time, molar fraction, depth, thickness, etc., or in combination of the parameters would be an unpatentable modification. Under some circumstances, however, changes such as these may impart

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patentability to a process if the particular ranges claimed produce a new and unexpected result which is different in kind and not merely degree from the results of the prior art ... such ranges are termed "critical ranges and the applicant has the burden of proving such criticality.... More particularly, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation." *In re Aller* 105 USPQ233, 255 (CCPA 1955). See also *In re Waite* 77 USPQ 586 (CCPA 1948); *In re Scherl* 70 USPQ 204 (CCPA 1946); *In re Irmischer* 66 USPQ 314 (CCPA 1945); *In re Norman* 66 USPQ 308 (CCPA 1945); *In re Swenson* 56 USPQ 372 (CCPA 1942); *In re Sola* 25 USPQ 433 (CCPA 1935); *In re Dreyfus* 24 USPQ 52 (CCPA 1934).

Regarding claims 13, 32, it is inherent that after annealing step, the substrate is needed to cool down to handling temperature.

Regarding claim 62, Gross discloses the removing gases comprises pumping the chamber to a pressure less than about 5 Torr (pressure was 2.9 mTorr, lines 30-35, Col. 5).

Regarding claims 16, 36, 55, Gross discloses the process gas comprises argon and nitrogen (lines 30-35, Col. 5).

Soininen et al., U.S. Patent Pub No. 20020092584, DeHaven et al., U.S. Patent No. 6,126,761, and Weaver et al. U.S. Pub No. 20030057614 also disclose the method of annealing similar to what recited in present claims.

When responding to the office action, Applicants' are advice to provide the examiner with the line numbers and page numbers in the application and/or references cited to assist the examiner to locate the appropriate paragraphs.

A shortened statutory period for response to this action is set to expire 3 (three) months and 0 (zero) day from the day of this letter. Failure to respond within the period for response will cause the application to become abandoned (see M.P.E.P 710.02(b)).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thao P. Le whose telephone number is 571-272-1785. The examiner can normally be reached on M-T (7-6).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, David Nelms can be reached on 571-272-1787. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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A handwritten signature in black ink, appearing to read 'Thao P. Le', with a long horizontal stroke extending to the right.

Thao P. Le

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October 31, 2005.